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ABSTRACT

An assessment was made of the effects of an automated tutoring program in teaching sixth grade disadvantaged children practical reading skills. Nineteen experimental and five control students were randomly selected and tested on 51 practical skills. Experimental students then received automated instruction on 24 of the skills. Correct answering yielded extrinsic reinforcement, and errors yielded audio tutoring. During instruction control students remained in their classrooms. After instruction all students were retested on the 51 skills. The experimental group's average skill's gain was significantly higher than the control group's. While experimental students showed greatest cross-test gains on skills trained during instruction, they also showed considerable improvement on the remaining uninstructed skills. (Author)

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Abstract

An assessment was made of the effects of an automated tutoring program in teaching sixth grade disadvantaged children practical reading skills. Nineteen experimental and 5 control students were randomly selected and tested on 51 practical reading skills. Experimental students then received automated instruction on 24 of the skills. Correct answering yielded extrinsic reinforcement, and errors yielded audio tutoring. During instruction control students remained in their classrooms. After instruction all students were retested on the 51 skills.

The experimental group's average pretest - posttest gain of 11.5 skills was significantly higher than the control group's 4.8 skill gain ($p < .01$). While experimental students showed greatest cross-test gains on skills trained during instruction, they also showed considerable improvement on the remaining uninstructed skills.

The Automated Instruction of Practical Reading Skills to Disadvantaged Sixth Grade Children[1]

Harold R. Strang, University of Virginia

A number of recent technological advances have afforded the educator an opportunity to automate elements of the time proven one-to-one student-teacher learning model. Applying computer technology, Atkinson (1968) and Green, Henderson and Richards (1969) have demonstrated CAI's effectiveness in helping elementary children to read. Kiesling (1970), however, has raised the question as to the economic practicality of CAI's widespread application in public schools.

Several electro-mechanical tutors developed around relatively simple memory functions have also been researched. Strang and Wolf (1971) developed a tutor capable of receiving student answers, giving immediate feedback as to accuracy, dispensing auditory tutoring whenever necessary, and dispensing secondary rewards for accuracy. Encouraging results were obtained when ghetto children received training in reading comprehension on such a tutor. In a later version of the tutor which included both audio and visual remedial help designed to more closely simulate actual student-teacher interactions, disadvantaged sixth grade students, after receiving the automated tutoring for a school year, showed more than double the reading improvement of students having received only classroom instruction (Strang, 1971).

Objectives

The current study centers around the use of the automated tutor in teaching disadvantaged sixth grade students a series of practical reading

skills -- that is, skills that relate to their every day activities both in and out of school.

The three specific aims of the research were:

(A) to assess the effectiveness of the automated tutoring in teaching 24 practical reading skills;

(B) to assess the automated tutoring's influence upon the tutored students' acquisition of 27 skills not included in instruction;

(C) to evaluate the practicality of the program as related to student gain, participation time, and cost.

Subjects

The entire experiment was conducted in an all sixth grade elementary school in Charlottesville, Virginia.

At the beginning of the school year a group of sixth grade students were selected on the bases of poverty backgrounds (defined by inclusion in the free hot lunch program), school records, and principal-teacher recommendations. The type of student sought was the child who was reading 2 to 2.5 years under grade level and yet showed academic potential as judged by principal-teacher reports. Final selection was based on the results of a battery of reading tests administered to these students. The machine administered tests included the Gates-MacGinitie Reading Test for grades 4 - 6 and the reading portion of the elementary level of the California Achievement Test, section G, Forms W and X.

As a result of testing, a pool of 25 students was obtained. Due to two factors, (1) the desire to help as many students as possible, and (2) former results indicating little reading improvement in control students

over a school year, it was decided to establish only a small control group. Nineteen students were randomly assigned to an experimental tutored group; 6 to a control group (after one month one control student moved from the area). Neither sex nor race was a criterion for student selection or for subsequent grouping. Of the 19 tutored students, 11 were black, 8 were white, and 11 were female, 8 were male. Of the controls, 4 were black, 1 was white, and 3 were female, 2 were male.

Procedures

Initially the study was conducted in an otherwise unoccupied classroom in the elementary school. All tutored and control students were given three sessions of orientation in which they were familiarized with the automated tutors and the extrinsic reward system. Next, all students were machine tested on 51 different practical reading skill items. After this testing, the control students returned to their regular classroom activities while the tutored students received automated instruction in the 24 skill areas showing the highest error densities. These areas included:

I. using reference tools
   - A. encyclopedia (4)*
   - B. dictionary (3)
   - C. atlas and maps (2)
   - D. card catalog (2)
   - E. tables and graphs (2)

II. newspaper reading
   - A. weather maps (1)
   - B. want ads (1)

III. reading airline schedules (1)

IV. using telephone directories

A. yellow pages (2)

B. white pages (2)

V. contents of forms and applications (e.g., catalog forms, checks, bills, job applications) (3)

VI. using mail order form catalogs (1)

*Number of specific behavioral objectives per skill area.

The students receiving the automated tutoring progressed through 10 programs, each consisting of 24 lessons representing every one of the 24 skills. A program was administered over a two-day period. Every attempt was made to draw the tutored students during their language arts periods.

The three automated tutors used both in testing and in instruction were similar to those described by Strang (1971). In summarizing their instruction functions, a student was initially presented with a projected frame including a multiple choice question pertaining to a practical reading skill (e.g., Above is a check written by Tom Beal. Which of the following items has he filled out incorrectly?).

Dependent upon the particular skill, the source of information necessary for the successful completion of each question was either presented above the question (as would be the case with the example above), or the student was informed by the tutor that he was to secure the information from a reference source close to the console (e.g., Use the atlas to help you answer this question: Which of the following countries is south east of Germany?).

The student was exposed to each frame for one minute before a light informed him that he could register an answer into the system. Although this controlled for extremely rapid answering patterns, it did not force a student to answer before he was ready. This one minute delay was imposed prior to all answering in all phases of the program except during testing when the student could answer as soon as a question was presented.

Immediately after answering, the student received feedback as to his accuracy. A correct answer yielded an advance to the next visual frame plus six reward points on a digital counter mounted at the right of the viewscreen. An incorrect answer yielded no reward points. Instead, immediate verbal tutorial help was presented through each student's headset via a tape recorder. The taped voice led the child through an orderly sequence of steps related to acquiring that particular skill. Never, however, was an answer given. After one minute of tutoring, the student could register a second answer into the system. A correct answer yielded only one reward point, but the child did advance to his next visual frame, where again he could earn six reward points for a ccrrect answer.

A second incorrect answer yielded no points and an imposed one minute time interval before another answer could be registered. This time delay procedure was repeated until the student registered a correct answer.

Each session, the students proceeded through 12 questions, each representing a different practical reading skill. During this time the apparatus automatically recorded the students' answering patterns for every question. Furthermore, measures of total time and time spent in tutoring were obtained.

After the 20 sessions of instruction in practical reading skills (240 lessons), all tutored and control students were retested on the 51 item test. No questions presented during the automated instruction were included on the test. Also, automated testing was identical to instruction with regard to administration of rewards and automatic recording. Any answer registered, however, regardless of its correctness, advanced the student to his next skill question and, if errors were made, no audio tutoring was administered.

Concerning the incentive system, the reward points that a student accumulated for a daily session could be redeemed for low-value extrinsic rewards at the end of the day (e.g., candy, gum, potato chips) or could be saved for high-value rewards obtained from local stores (e.g., notebooks, models, jewelry). The monetary value of each point was .2 of a cent.

Results

Table 1 depicts the progressive downward trend in the average number of errors (both before and after tutoring) committed by the tutored students as they proceeded through the 10 programs. On the tenth program, 17 of the 19 tutored students registered at least 50% fewer errors than they had on Program 1.

Insert Table 1 here

Concerning progress on individual skills, Table 2 illustrates the five skills where the greatest and the five skills where the least cross-program improvement occurred.

Insert Table 2 here

Table 3 shows both the tutored and control students' cross-test performance on all 51 skills, on the 24 skills included in the automated tutoring, and finally on the 27 skills not included in the tutoring. A parametric statistical analysis of the groups' differential improvement on each of these measures was deemed inappropriate due to the gross inequality of the group sizes. The data were, therefore, ranked on each measure, and Wilcoxon Signed Rank tests (1964) were performed. On total performance, the tutored group improved significantly more than the control (T_L = 28.5, p .02). Tutored students also showed significantly greater improvement than the control students on those skills included in automated instruction (T_L = 29.5, p .02). Although inspection revealed that tutored students improved substantially more than control students in those skills not included in the automated tutoring, a statistically significant difference was not shown.

Insert Table 3 here

As related to individual progress, it was considered excellent if a student decreased the number of errors across the test by at least 50%. As Table 3 illustrates, the majority of tutored students achieved this standard on all three measures, whereas a low ratio of control students achieved such a standard on any of the measures.

Program Efficiency: Time, Monetary Investment and Recorded Gains

The tutored students averaged 10.6 hours of automated instruction to complete the 240 lessons in the 10 programs. The average pretest - posttest improvement attained by the control group served as a basis for assessing the effects of retesting and normal classroom instruction on acquisition of practical skills. Thus, to obtain a measure of the automated tutoring's effect upon practical skill acquisition, the control group's average cross-test gain was subtracted from the tutored group's cross-test gain. Applying this correction factor, it was found that the 19 tutored students learned a total of 129 practical skills. All but one tutored student showed a corrected gain, and individual students gained as many as 15 new reading skills.

The average cost for the extrinsic rewards used during the tutoring amounted to $.33 per corrected acquired skill.

Discussion

The test-derived data clearly demonstrated the powerful effect of the automated procedure upon the learning of the practical reading skills. Improvement appeared not only as group statistical gains, but also as individual gains exhibited by a majority of the tutored students. As might be expected, these students showed greatest improvement over the control group on skills included in the automated instruction phase. Even on items not included in instruction, however, the tutored students' cross-test improvement averaged over two times that shown by the control group. Further supporting the automated instruction's generalization, almost two-thirds of the tutored students showed a cross-test reduction in errors of at least 50% in these items.

In viewing the tutored students' superior progress, it must also be realized that these students had the disadvantage of receiving an average of approximately 11 hours less time in language arts classwork than the control students.

Regarding the automated tutor's effect on the acquisition of individual practical skills, cross-test item analyses indicated that students showed excellent progress in 21 of the machine-instructed skills. On three, however, revision of the tutoring is needed.

The size and universality of the reading skill gains, coupled with minimal incentive costs, certainly attest to the practicality of the automated tutoring. The question, however, as to whether the efficiency of the system could be further increased by omitting the back-up rewards remains unanswered, for in the present study it was considered impractical to establish the necessary control group when limited to only one school setting. Current plans include a systematic investigation of this variable.

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Footnotes

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Table 1

Total Number of Errors Committed Per Program

	Program									
	1	2	3	4	5	6	7	8	9	10
$\bar{X}$	15.47	14.21	10.47	8.26	11.16	10.53	7.16	5.84	5.84	4.00
SD	7.52	6.73	4.54	5.05	5.39	5.11	4.11	4.44	4.52	3.54

Table 2

Skills in Which Tutored Students Showed Most and Least Improvement

Skill	Average number of total errors students committed per skill per program	
	Programs 1 - 2	Programs 9 - 10
Skills showing most improvement		
Finding correct volume of encyclopedia	25	0
Filling in order blanks	28	4
Reading want ads	25	2
Reading legends on maps	23	4
Interpreting graphs	17	2
Skills showing least improvement		
Extracting quantitative data from bills	8	13
Establishing geographic directions on atlas maps	17	20
Extracting facts from encyclopedias	5	7
Use of author's name to find book titles in card catalogs	3	3
Identification of error in forms	10	5

Table 3

Performance on the Constructed Pre- and Posttests

Measure	Mean pretest error frequencies	Mean posttest error frequencies	Number of students showing at least 50% fewer errors on posttest
Tutored Students (N=19)			
Total performance[a]	19.21	7.74	13
Performance on skills included in tutoring	12.47	4.47	15
Performance on skills not included in tutoring	6.84	3.21	12
Control Students (N=5)			
Total performance	16.20	11.40	1
Performance on skills included in tutoring	10.60	7.20	1
Performance on skills not included in tutoring	6.00	4.60	2

[a]Of the 51 total skills tested, 24 had been included in the tutoring phase while 27 had not.